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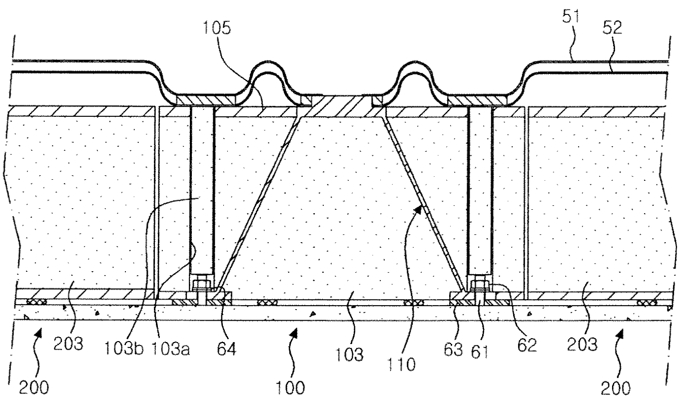
(54) **Structure for liquefied natural gas storage tank**

(57) Anchor and corner structures of an LNG storage tank are disclosed. The LNG storage tank (10) comprise a heat insulating wall on an inner surface (12, 14) of the storage tank, a sealing wall (51, 52) contacting LNG on the heat insulating wall, and a structure to support the sealing wall. The structure comprises an anchor structure (100), which comprises an anchor member (110, 130) between the inner surface (12, 14) of the storage tank and the sealing wall to secure the sealing wall to the inner surface, and a heat-insulating material (203) around the anchor member. The anchor member (110, 130) is coupled at several portions to the inner surface. The structure provides a simple configuration to the heat insulating wall and the sealing wall, and a simple connection therebetween, enabling convenient construction thereof while increasing sealing reliability. The structure simplifies an assembled structure and a manufacturing process, reducing a construction time of the tank while efficiently relieving stress on the tank.

Fig. 6



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to liquefied natural gas (LNG) storage tanks built in marine vessels, and more particularly to anchor and corner structures which are arranged to construct a heat insulating wall and sealing walls on an inner wall of an LNG storage tank built in a marine vessel for storage and transport of LNG in a cryogenic state.

Description of the Related Art

[0002] Liquefied natural gas (LNG) is formed through liquefaction of natural gas, one of fossil fuels, and stored in LNG storage tanks. According to an installation location, the LNG storage tanks are typically classified into on-land storage tanks built above or in the ground, and movable storage tanks installed on carriers such as vehicles, marine vessels, etc.

[0003] Since LNG is likely to explode if in a collision and is stored in a cryogenic state, the LNG storage tank must be firmly collision resistant and liquid-tight.

[0004] Compared with the on-land storage tank, which experiences little movement of LNG, the LNG storage tank installed on vehicles or marine vessels experiences movement of LNG, and is thus required to have a countermeasure capable of relieving mechanical stress caused by the movement of LNG. In this regard, since the LNG storage tank installed in the marine vessel with the countermeasure against the mechanical stress can be reasonably used as the on-land storage tank, the structure of the LNG storage tank installed in the marine vessel will hereinafter be described as an example herein.

[0005] Fig. 1 is a cross-sectional view schematically showing a marine vessel in which a conventional LNG storage tank is installed.

[0006] Referring to Fig. 1, the marine vessel 1 with the conventional LNG storage tank therein has a double walled hull, which comprises an outer wall 16 constituting an appearance of the marine vessel and an inner wall 12 formed inside the outer wall 16. The inner and outer walls 12 and 16 of the marine vessel 1 are integrally connected to each other by connection ribs 13. In some cases, the marine vessel 1 can be constituted by a single walled hull, which does not comprise the inner wall 12.

[0007] In addition, the interior of the hull, that is, the interior of the inner wall 12, can be divided by one or more partitions 14. The partitions 14 can be formed by known cofferdams, which are installed in typical floating storage offloading vessels like the marine vessel 1 of Fig. 1.

[0008] Each of inner spaces divided by the partitions 14 can be utilized as a storage tank 10 to store a cryogenic liquid such as LNG.

[0009] Here, an inner peripheral surface of the storage tank 10 is liquid-tightly sealed by a sealing wall 50. In other words, the sealing wall 50 defines a single storage space therein with a plurality of metal plates integrally welded together, so that the storage tank 10 can store and transport LNG without any leakage.

[0010] The sealing wall 50 in direct contact with LNG in the cryogenic state can be formed with corrugation to endure temperature variation caused by the loading and unloading of LNG, as known in the art. The sealing wall 50 is fixedly connected to the inner wall 12 or the partition 14 of the vessel 1 by a plurality of anchor structures 30. Thus, the sealing wall 50 cannot be moved with respect to the hull.

[0011] A heat insulating wall is arranged between the sealing wall 50 and the inner wall 12 or the partition 14 to form a heat insulating layer therebetween. The heat insulating wall comprises a corner structure 20 disposed at a corner of the storage tank 10, an anchor structure 30 disposed around an anchor member (not shown), and a planar structure 40 disposed on a planar section of the storage tank 10. In this wary, the overall heat insulating layer can be formed on the storage tank 10 by the corner structure 20, anchor structure 30, and planar structure 40.

[0012] Here, the anchor structure 30 comprises a rod-shaped anchor member directly connected between the sealing wall and the hull to secure the sealing wall to the hull, and a heat-insulating material surrounding the anchor member.

[0013] The anchor structure 30 mainly serves to support the sealing wall 50, whereas the corner structure 20 and the planar structure 40 mainly serve to support only a load of LNG exerted on the sealing wall 50 and are not directly connected to the anchor structure 30.

[0014] Fig. 2 is a cross-sectional view showing a part of a conventional LNG storage tank disclosed in Korean Patent No. 499710 issued to the applicant of this invention.

[0015] Referring to Fig. 2, the conventional LNG storage tank 10 comprises a primary heat insulating wall 24, 34, 44 and a secondary heat insulating wall 22, 32, 42 sequentially stacked on the bottom of a hull, and a secondary sealing wall 23, 33, 43 between the primary heat insulating wall 24, 34, 44 and the secondary heat insulating wall 22, 32, 42 to seal the heat insulating walls. In addition, a primary sealing wall 50 is disposed on the primary heat insulating wall 24, 34, 44.

[0016] The LNG storage tank 10 constructed as described above further comprises a corner structure 20 disposed at an inside corner, an anchor structure 30 separated a predetermined distance from the bottom, and a planar structure 40 slidably interposed between corner structures 20 or anchor structures 30. The corner structure 20, the anchor structure 30, and the planar structure 40 are manufactured as unit modules that can be assembled onto the storage tank 10. Then, with these structures assembled onto the storage tank 10, the primary sealing wall 50 is finally disposed on the assembled structures to provide liquid-tightness to the heat insulating walls, thereby defining a space to store LNG in the storage tank.

[0017] As shown in Fig. 2, each of the corner structure 20, the anchor structure 30, and the planar structure 40 comprises the primary heat insulating wall 24, 34, 44, the secondary heat insulating wall 22, 32, 42, and the secondary sealing wall 23, 33, 43, which will be commonly defined as heat insulating wall structures 20, 30 and 40.

[0018] Meanwhile, in each unit module of the heat insulating wall structures 20, 30 and 40, the secondary sealing wall and each of the heat insulating walls are integrally bonded together at a contact face therebetween by adhesives. Typically, the secondary heat insulating wall 22, 32, 42 is constituted by polyurethane foam, one of heat insulating materials, and a plate bonded to a lower surface of the polyurethane foam. The primary heat insulating wall 24, 34, 44 is constituted by the polyurethane foam, and a plate bonded to an upper surface of the polyurethane foam by the adhesives. In addition, the primary sealing wall is positioned on the primary heat insulating wall 24, 34, 44, and welded to the anchor structure 30.

[0019] The secondary heat insulating wall 42 of the planar structure 40 is formed at a lower end with a flange 42a greater than the secondary heat insulating wall 42. The flange 42a is fitted into a groove formed in the lower end of the anchor structure 30 to slide somewhat therein.

[0020] In the construction shown in the drawing, the anchor structure 30 comprises an anchor support rod 36, a securing member 37 positioned at a lower portion of the anchor structure 30, the primary anchor heat insulating wall 34, the secondary anchor heat insulating wall 32, and the secondary sealing wall 33 interposed between the primary anchor heat insulating wall 34 and the secondary anchor heat insulating wall 32. The anchor support rod 36 is connected at one end to the primary sealing wall 50, and at the other end to the inner wall 12 of the hull via the securing member 37.

[0021] The anchor support rod 36 of the anchor structure 30 has an upper end welded to the primary sealing wall 50.

[0022] Furthermore, the anchor structure 30 is positioned at a connection between the adjacent planar structures 40 to connect the planar structures 40, which are secured to the inner wall 12 or the partition 14 constituting the storage tank 10. The securing member 37 of the anchor structure 30 is disposed around the anchor support rod 36.

[0023] As such, since the heat insulating wall structures of the conventional LNG storage tank comprise the primary and secondary heat insulating walls, and the primary and secondary sealing walls, the conventional LNG storage tank is complicated in overall construction, in particular, in construction for connecting the secondary sealing wall, which makes it difficult to construct the heat insulting walls. Furthermore, the complicacy in construction and installation of the anchor structure or the connecting structure for the secondary sealing walls deteriorates reliability in sealing properties of the secondary sealing wall with respect to LNG, which can cause leakage of LNG.

[0024] Furthermore, for the conventional anchor structure 30 which connects the inner surface of the hull and the primary sealing wall 50 via the anchor support rod 36, and the conventional corner structure 20 which supports only the load of LNG exerted on the sealing wall 50 without supporting the sealing wall 50, it has been required to further improve capability of absorbing stress occurred upon thermal deformation of the storage tank or deformation of the hull resulting from the loading and unloading of LNG in the cryogenic state.

[0025] In order to achieve reduction of boiled off gas (BOG), which is a loss caused by vaporization of LNG in the cryogenic state, and simplification in the construction and manufacturing process while solving the aforementioned problems, an LNG storage tank having new construction completely different from that of the conventional LNG storage tank has been suggested. As a result, there are needs of improved anchor and corner structures corresponding to the new LNG storage tank.

SUMMARY OF THE INVENTION

[0026] The present invention has been made to solve the above problems, and it is an aspect of the present invention to provide improved structure of a liquefied natural gas storage tank, which provides simple construction of a heat insulating wall and sealing walls, and a simple connecting structure between the heat insulating wall and the sealing walls, enabling convenient assembly thereof, which increases the reliability of sealing while simplifying the assembled structure and manufacturing process, thereby reducing a construction time of the storage tank, and which can efficiently relieve mechanical stress exerted on the storage tank by use of an anchor member and a corner member.

[0027] In accordance with one aspect of the present invention, there is provided a structure of a liquefied natural gas (LNG) storage tank comprising a heat insulating wall disposed on an inner surface of the LNG storage tank to form a heat insulating layer, sealing walls disposed on the heat insulating wall to directly contact LNG, and the structure to support the sealing walls, wherein the structure comprises an anchor structure including an anchor member connected between the sealing walls and the inner surface of the storage tank to secure the sealing walls to the inner surface of the storage tank, and a heat-insulating material formed around the anchor member, the anchor member being connected at a plurality of locations to the inner surface of the storage tank.

[0028] The structure of the LNG storage tank may further comprise a corner structure disposed at a corner of the storage tank to support the sealing walls.

[0029] The corner structure may comprise a corner member connected between the sealing walls and the inner surface of the storage tank to secure the sealing walls to the inner surface thereof, and a heat-insulating material formed around the corner member, the corner member comprising a fixed member secured to the inner surface of the corner of the storage tank and a movable member supported on the fixed member to linearly move thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings:

Fig. 1 is a cross-sectional view schematically showing a marine vessel in which a conventional LNG storage tank is built;
Fig. 2 is a cross-sectional view showing a part of the conventional LNG storage tank;
Fig. 3 is a perspective view of an anchor member disposed in an LNG storage tank according to one embodiment of the present invention;
Fig. 4 is a partially cut-away perspective view of the anchor member shown in Fig. 3;
Fig. 5 is a plan view showing a part of the LNG storage tank in which an anchor structure comprising the anchor member shown in Fig. 3 is built;
Fig. 6 is a partially cross-sectional view taken along line A-A of Fig. 5;
Fig. 7 is a perspective view of an anchor member in the LNG storage tank according to an alternative embodiment of the present invention;
Fig. 8 is a partially cut-away perspective view of the anchor member shown in Fig. 7;
Fig. 9 is a perspective view of a corner member in the LNG storage tank according to one embodiment of the present invention;
Fig. 10 is a longitudinal cross-sectional view illustrating a part of the LNG storage tank in which a corner structure comprising the corner member of Fig. 9 is disposed;
Fig. 11 is a transverse cross-sectional view of the corner structure taken along line B-B of Fig. 10; and
Fig. 12 is a transverse cross-sectional view of the corner structure taken along line C-C of Fig. 10.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] Exemplary embodiments will now be described in detail with reference to the accompanying drawings.

[0032] First, there will be described an anchor member and an anchor structure disposed in an LNG storage tank according to the present invention with reference to Figs. 3 to 8.

[0033] Figs. 3 and 4 are a perspective view and a partially cut-away perspective view of an anchor member disposed in an LNG storage tank according to one embodiment of the present invention, and Figs. 5 and 6 are a plan view and a cross-sectional view showing a part of the LNG storage tank in which an anchor structure comprising the anchor member is disposed.

[0034] Referring to Figs. 3 and 4, the anchor member 110 according to the embodiment has a frustoconical shape having a planar top surface. The frustoconical anchor member 110 is closed at an upper portion and opened at a lower portion.

[0035] The anchor member 110 comprises a frustoconical body 111, which is provided at the lower portion with a securing part 112, through which the anchor member 110 is secured to an inner surface of a storage tank 10, that is, an inner wall 12 or a partition 14, as will be described as follows with reference to Figs. 5 and 6.

[0036] Although the securing part 112 is illustrated as having a ring shape formed along an overall outer circumference at a lower end of the body 111 of the anchor member 110, it should be noted that the securing part 112 may be partially formed along the outer circumference at the lower end thereof.

[0037] In this embodiment, the ring-shaped securing part 112 is produced as a separate member, and then integrally welded to the lower end of the body 111 of the anchor member 110.

[0038] In addition, the securing part 112 has a plurality of through-holes 112a formed at constant intervals therein such that a plurality of stud bolts 61 secured to the inner surface of the storage tank 10 can be inserted into the through-holes 112a and fastened by nuts 62, respectively.

[0039] The anchor member 110 has a step on the top surface of the frusto-conical body 111 so that two junction parts, that is, a first junction part 113 and a second junction part 114, are formed to have a predetermined height difference therebetween. First and second sealing walls 51 and 52 are welded to the first and second junction parts 113 and 114, as will be described below with reference to Fig. 6.

[0040] In this embodiment, the first and second junction parts 113 and 114 are separately produced and then integrally joined to the upper end of the body 111 of the anchor member 110 by welding, thereby closing the upper end of the body 111 of the anchor member 110.

[0041] Referring to Figs. 5 and 6, the storage tank 10 has an inner peripheral wall liquid-tightly sealed by the first and second sealing walls 51 and 52. In other words, the first and second sealing walls 51 and 52 define a single storage space with a plurality of metal plates integrally joined together by welding, so that the storage tank 10 can store and transport LNG without any leakage.

[0042] The first sealing wall 51 directly contacting LNG in the cryogenic state, and the second sealing wall 52 spaced from the first sealing wall 51 may have corrugation, as known in the art, to endure temperature variation resulting from loading and unloading of LNG.

[0043] The first and second sealing walls 51 and 52 are fixedly connected to the inner wall 12 or the partition 14 of the marine vessel 1 via a plurality of anchor structures 100. Thus, the first and second sealing walls 51 and 52 cannot be moved with respect to the hull.

[0044] A heating insulating wall is arranged between the second sealing wall 52 and the inner wall 12 or the partition 14 to form a heat insulating layer therebetween. The heat insulating wall is constituted by a corner structure (not shown) disposed at a corner of the storage tank 10, the anchor structure 100 disposed around the anchor member 110, and a planar structure 200 disposed on a planar section of the storage tank 10. In other words, the overall heat insulating layer of the storage tank 10 may be formed by the corner structure, anchor structure 100, and planar structure 200.

[0045] The anchor structure 110 serves to support the first and second sealing walls 51 and 52, whereas the planar structure 200 serves to support only the load of LNG exerted on the first and second sealing walls 51 and 52, and has no direct coupling relation with respect to the anchor structure 110.

[0046] Here, the anchor structure 100 comprises the anchor member 110 directly connected between the first and second sealing walls 51 and 52 and the hull to secure the first and second sealing walls 51 and 52 to the hull, and a heat-insulating material 103 integrally formed of polyurethane foam or reinforced polyurethane foam to surround the anchor member 110.

[0047] Plywood 105 may be attached to one or both of the upper and lower ends of the heat-insulating material 130. Although the plywood is illustrated as being attached to the upper end of the anchor structure 100 and the upper and lower ends of the planar structure 200 in Fig. 6, it should be noted that the present invention is not limited to this structure.

[0048] The anchor heat-insulating material 103 in the anchor structure 10 has a density of about 35 - 45 kg/m^3, which is lower than the density of a planar heat-insulating material 203 of the planar structure 200 in the range of about 115 ~ 125 kg/m^3. In this regard, although the density of the anchor heat-insulating material 103 is lower than that of the planar heat-insulating material 203, the anchor structure 100 can maintain a sufficient strength due to the anchor member 110 embedded therein.

[0049] The anchor structure 100 constructed as above is secured to the inner surface of the storage tank 10 via the securing part 112 formed at the lower portion of the frustoconical body 111 of the anchor member 110.

[0050] As described above, the securing part 112 is formed with the plurality of through-holes 112a arranged at constant intervals, and the plurality of stud bolts 61 previously secured to the inner surface of the storage tank 10 are inserted through the holes 112a and fastened by the nuts 62, respectively.

[0051] For this purpose, the anchor heat-insulating material 103 has a lower surface coplanar with a lower surface of the securing part 112, and is formed with a plurality of cylindrical hollows 103a extending in upper and lower directions at portions of the anchor heat-insulating material 103 corresponding to the through-holes 112a of the securing part 112.

[0052] The cylindrical hollows 103a may be formed in such a way that the heat-insulating material is not formed in the cylindrical hollow part 103a by use of a mold when forming the heat-insulating material at an initial stage, or in such a way that the heat-insulating material is formed in a hexahedral shape around the anchor member 110 and then cut away at portions corresponding to the cylindrical hollows 103a.

[0053] After positioning the anchor structure 100 such that the stud bolts 61 can be inserted through the through-holes 112a, the nuts 62 are inserted through the cylindrical hollows 103a, and fastened to the stud bolts 61, securing the anchor structure 100 to the inner surface of the storage tank 10.

[0054] At this time, a leveling plate 63 may be interposed between the lower surface of the securing part 112 of the anchor member 110 and the inner surface of the storage tank 10 to level off, if necessary, as well known in the art. Furthermore, a washer 64 may be interposed between an upper surface of the securing part 112 of the anchor member 110 and the nuts 62 fastened to the stud bolts 61, as well known in the art.

[0055] After securing the anchor structure 100 to the inner surface of the storage tank 10 by fastening the nuts 62 inserted through the cylindrical hollows 103a to the stud bolts 61, a cylindrical heat-insulating material 103b having a shape corresponding to that of the cylindrical hollows 103a is inserted into each of the cylindrical hollows 103a.

[0056] In addition, as described above, the first junction part 113 and the second junction part 114 are formed to have the predetermined height difference on the top surface of the frustoconical body 111 of the anchor member 110. The first and second sealing walls 51 and 52 are fixedly joined to the first and second junction parts 113 and 114 by welding, respectively.

[0057] Meanwhile, although sealing structure is illustrated as having the double structure of the first sealing wall 51 and the second sealing wall 52 in Fig. 6, the sealing structure may be embodied by a multilayer structure of three layers or more.

[0058] As such, according to the present invention, the plurality of stud bolts 61 secured to the inner surface of the storage tank are inserted into the plurality of through-holes 112a formed along the ring-shaped securing part 112 of the anchor member, and then fastened by the nuts 62, respectively, so that the anchor member 110 and the sealing walls 51 and 52 can be secured to the hull.

[0059] In this way, coupling between the anchor member 110 and the inner surface of the storage tank can be accomplished by a simple operation of nut fastening.

[0060] Furthermore, since the anchor member 110 and the inner surface of the storage tank are coupled to each other at a plurality of consecutive locations, it is possible to certainly absorb stress resulting from thermal deformation caused by loading and unloading of LNG or from deformation of the hull caused by an external force such as waves.

[0061] Figs. 7 and 8 are a perspective view and a partially cut-away perspective view of an anchor member according to an alternative embodiment of the present invention. In the embodiment described above, the anchor member 110 is constituted by attaching the separately produced securing part 112, first junction part 113, and second junction parts 114 to the lower and upper ends of the frustoconical body 111. Compared with such an anchor member 110, an anchor member 130 according to this embodiment comprises a body with which a securing part and junction parts are integrally formed, and which has a plurality of through-holes formed therein. Hereinafter, the anchor member 130 of the alternative embodiment will be described mainly in view of different features from the anchor member 110.

[0062] As in the above embodiment, the anchor member 130 of the alternative embodiment has a frustoconical body having a planar top surface, which is closed at the upper surface and opened at a lower surface, as shown in Figs. 7 and 8.

[0063] As in the above embodiment, the anchor member 130 comprises a frustoconical body 131, which is integrally formed at a lower portion with a securing part 132 through which the anchor member 130 is secured to the inner surface of the storage tank 10.

[0064] The securing part 132 has a plurality of through-holes 132a formed at constant intervals therein such that a plurality of stud bolts 61 secured to the inner surface of the storage tank 10 can be inserted into the through-holes 112a and fastened by nuts 62, respectively.

[0065] As in the above embodiment, the frustoconical body 131 of the anchor member 130 is integrally formed at the top surface with first and second junction parts 113 and 114, which have a predetermined height difference and are respectively welded to the first and second sealing walls 51 and 52.

[0066] It is desirable that a reinforcing plate 135 be integrally mounted inside an upper end of the anchor member 130 by welding, as shown in Fig. 8, to provide a double structure to the upper portion of the anchor member 130 where the first and second junction parts 133 and 134 are formed.

[0067] The plurality of through-holes 131a is preferably arranged in a zigzag pattern in the body 131 of the anchor member 130 according to this embodiment. Additionally, by forming the through-holes 131a to have an elliptical shape as well as being arranged in the zigzag pattern on the body 131, there is an effect of extending a transfer path of cold energy from an upper end to a lower end of the anchor member 130, which can prevent loss of the cold energy.

[0068] According to the alternative embodiment, the configuration of forming the heat-insulating material to surround the anchor member 130, the configuration of forming the anchor structure with the anchor member 130 and the heat-insulating material, the configuration of securing the anchor structure comprising the anchor member 130 to the hull and the first and second sealing walls 51 and 52 are the same as those of the above embodiment, and thus are omitted hereinafter.

[0069] In this way, the alternative embodiment has not only advantages of the above embodiment, but also other advantages as follows. That is, according to the alternative embodiment, since the anchor member can be formed as a single component by pressing, a process of producing the anchor member can become more simple, and since the elliptical through-holes are arranged in the zigzag pattern on the body of the anchor member to increase the transfer path of the cold energy, it is possible to further reduce the loss of the cold energy.

[0070] Referring to Figs. 9 to 12, there will hereinafter be described a corner member and the corner structure for the LNG storage tank according to the present invention.

[0071] Fig. 9 is a perspective view of a corner member according to one embodiment of the present invention, and Fig. 10 is a longitudinal cross-sectional view showing a part of the LNG storage tank in which the corner structure comprising the corner member shown in Fig. 9 is built. Figs. 11 and 12 are transverse cross-sectional views of the corner structure taken along line B-B and line C-C shown in Fig. 10, respectively.

[0072] In Figs. 9 to 12, the corner member 301 of this embodiment comprises a fixed member 310 secured to the inner surface of the storage tank 10, that is, the surface of the inner wall 12 or the partition 14, and a movable member 330 supported on the fixed member 310 while being joined to the sealing walls 51 and 52.

[0073] The movable member 330 is installed to have a very minute movement in a linear direction with respect to the fixed member, as will be described below, when there occurs thermal deformation caused by temperature variation resulting from loading and unloading of LNG in the cryogenic state or deformation of the hull by waves.

[0074] As viewed from the front side, the fixed member 310 has a cross shape (+) wherein four extensions, that is, first to fourth extensions 311a to 311d, cross each other at right angles. Among these first to fourth extensions 311a to 311d, adjacent two extensions, that is, the first and second extensions 311a and 311b, are secured to the inner surface of the storage tank 10, and the remaining two extensions, that is, the third and fourth extensions 311c and 311d, support the movable member 330.

[0075] The first to fourth four extensions 311a to 311d may be formed separately, and then integrally joined to each other by welding and the like. Alternatively, the two extensions, that is, the first and second extensions 311a and 311b or the second and fourth extensions 311c and 311d, may be formed as an integral component, and then integrally joined to another integral component of other two extensions by welding and the like.

[0076] To enlarge a contact area with respect to the inner surface of the storage tank 10, the first and second two extensions 311a and 311b preferably have a trapezoidal shape (see Fig. 10) of which the width increases toward the storage tank 10, as viewed in the lateral side.

[0077] Each of the first and second extensions 311a and 311b is formed at a distal end with a securing part 312, as will be described below with reference to Figs. 10 to 12, which serves to secure the corner member 301 to the inner surface of the storage tank 10, that is, the surface of the inner wall 12 or the partition 14.

[0078] The securing parts 312 may be integrally formed with the first and second extensions 311a and 311b, or may be individually formed and integrally joined thereto by welding and the like.

[0079] The securing part 312 has a plurality of through-holes 312a formed at constant intervals therein such that a plurality of stud bolts 61 secured to the inner surface of the storage tank 10 can be inserted into the through-holes 312a and fastened by nuts 62, respectively.

[0080] In Figs. 10 and 11, each of the third and fourth extensions 311c and 311d is formed with a through-hole 314 into which a bolt 309 is inserted and fastened to the movable member 330, and with a guide recess 313 which guides the movable member 330 to minutely move in the linear direction while being supported on the fixed member.

[0081] The movable member 330 has a substantially L-shape to be disposed along the corner of the storage tank 10.

[0082] The movable member 330 is formed with two junction parts, that is, first and second junction parts 331 and 332, to have a predetermined height difference therebetween. The first and second sealing walls 51 and 52 are secured to the first and second junction parts 331 and 332 by welding.

[0083] Each part of the movable member 330 facing the fixed member 310 is formed with a through-hole 334 through which the bolt 309 is inserted and fastened to the fixed member 310, and with a guide protrusion 333 to guide the movable member 330 to be minutely moved in the linear direction along the guide recess 313 of the fixed member 310, as shown in Figs. 10 and 11.

[0084] Preferably, two guide protrusions 333 are made independent of the movable member 330, and joined integral to locations of the movable member 330 corresponding to the guide recesses 313 of the fixed member 310 by welding, as shown in Fig. 11, after positioning the movable member 330 on the fixed member 310. The reason is that, if the two guide protrusions 333 are integrally formed with the movable member 330, the guide protrusions 333 of the movable member 330 cannot be inserted into the guide recesses 313 of the fixed member 310 due to interference with the guide recesses 313 when positioning the movable member 330 on the fixed member 310, failing to couple the fixed member 310 to the movable member 330.

[0085] The movable member 330 constructed as above is positioned and supported on two fixed members spaced a predetermined distance from each other along the corner of the storage tank 10.

[0086] As shown in Figs. 10 to 12, each of the fixed members 310 can be secured to the inner surface of the storage tank 10 by inserting the plurality of stud bolts 61 secured to the inner surface of the storage tank 10 into the through-holes 312a formed in the securing part 312 of the fixed member 310, and then fastening the nuts 62 to the stud bolts 61.

[0087] In addition, the movable member 330 is coupled at opposite sides to the fixed members 310 by fastening the bolts 309 inserted through the through-holes 334 formed at opposite sides of the movable member 330 and through the through-holes 314 formed in the third and fourth extensions 311c and 311d of the fixed members 310 after positioning the opposite sides of the movable member 330 on the fixed members 310 secured to the inner surface of the storage tank 10, as described above.

[0088] Here, the coupling between the movable member 330 and the fixed members 310 is realized so as not to avoid a relative movement therebetween. Rather, the movable member 330 is coupled to the fixed members 310 such that the movable member 330 can be linearly moved by the guide recesses 313 of the fixed members 310 and the guide protrusions 333 of the movable member 330, as described above, when the movable member 330 is stretched or compressed in the longitudinal direction.

[0089] For this purpose, the through-holes at one side among the through-holes 334 formed at the opposite sides of the movable member 330 and the through-holes 314 formed in the third and fourth extensions 311c and 311d of the fixed member 310 are preferably formed in an elongated shape.

[0090] Preferably, the corner member 301 further comprises a connection member 320, which is disposed at the middle between the fixed members 310, that is, at the middle of the movable member 330, and has a shape similar to that of the fixed member 310.

[0091] As in the first and second extensions 311a and 311b of the fixed member, the connection member 320 preferably also has a trapezoidal shape (see Fig. 10) of which the width increases toward the storage tank 10, as view from the lateral side, in order to enlarge a contact area with respect to the inner surface of the storage tank 10.

[0092] At one end of the connection member 320, the connection member 320 is integrally provided with securing parts 322 in which through-holes 322a are formed. Thus, as in the fixed member 310, the connection member 320 is secured to the inner surface of the storage tank 10 by inserting a plurality of stud bolts 61 secured to the inner surface of the storage tank 10 into the through-holes 322a of the connection member 320, and then fastening the nuts 62 to the stud bolts 61.

[0093] Meanwhile, the other end of the connection member 320 is respectively joined to the movable member 330 by, for example, welding. The movable member 330 is formed at corresponding locations with welding slots 336 for joining the connection member 320 to the movable member 330 via welding. Thus, even when the movable member 330 is laid on the connection member 320 and the fixed members 310 after mounting the connection member 320 and the fixed members 310 on the inner surface of the storage tank 10, it is possible to integrally join the movable member 330 and the connection member 320 via the welding slots 336.

[0094] As such, the movable member 330 is integrally secured to the inner surface of the storage tank 10 via the connection member 320 at the middle of the movable member 330 in the longitudinal direction, while being coupled at the opposite ends thereof to the fixed members 310 so as to be minutely moved in the linear direction with respect to the fixed member 310.

[0095] The inner peripheral surface of the storage tank 10 is liquid-tightly sealed by the first and second sealing walls 51 and 52. In other words, the first and second sealing walls 51 and 52 define a single storage space with a plurality of metal plates integrally joined together by welding, so that the storage tank 10 can store and transport LNG without any leakage.

[0096] The first sealing wall 51 in direct contact with LNG in the cryogenic state, and the second sealing wall 52 spaced from the first sealing wall 51 may have corrugation to endure the temperature variation caused by the loading and unloading of LNG, as known in the art.

[0097] The first and second sealing walls 51 and 52 are fixedly connected to the inner wall 12 or the partition 14 of the marine vessel 1 by a plurality of the corner structures 300 and anchor structures. Thus, the first and second sealing walls 51 and 52 cannot be moved with respect to the hull.

[0098] A heat insulating wall may be disposed between the second sealing wall 52 and the inner wall 12 or the partition 14 to form a heat insulating layer therebetween. The heat insulating wall comprises the corner structure 300 disposed at the corner of the storage tank 10, the anchor structure 100 disposed around an anchor member, and the planar structures 200 disposed on a planar portion of the storage tank 10. As such, the overall heat insulating layer can be formed by the corner structure 300, anchor structure 100, and planar structure 200.

[0099] The corner structure 300 and the anchor structure 100 serve to support the first and the second sealing walls 51 and 52, whereas the planar structure 200 serves to support a load of LNG exerted on the sealing walls 51 and 52 without being directly coupled to the anchor structure 100 (see Fig. 10).

[0100] Here, the corner structure 300 comprises the corner member 301 directly connected between the first and second sealing walls 51 and 52 and the hull to secure the first and second sealing walls 51 and 52 to the hull, and a heat-insulating material 303 integrally formed of polyurethane foam or reinforced polyurethane foam to surround the corner member 310.

[0101] Plywood 305 may be attached to one or both of upper and lower ends of the heat-insulating material 303. Although the plywood is illustrated as being attached to the upper end of the corner structure 300 and the upper and lower ends of the planar structure 200 in Figs. 4 to 6, the present invention is not limited to this structure.

[0102] The corner structure 300 constructed as above is secured to the inner surface of the storage tank 10 via the securing parts 312 and 322 of the fixed member 310 and the connection member 320 of the corner member 301.

[0103] As described above, the securing parts 312 and 322 are formed with the plurality of through-holes 312a and 322a at constant intervals, through which the stud bolts 61 previously secured to the inner surface of the storage tank 10 are inserted and fastened by the nuts 62, respectively.

[0104] In addition, the leveling plate 63 may be interposed between the plywood 305 and 205 attached to the lower surfaces of the heat-insulating materials 303 and 203 and the inner surface of the storage tank 10 to level off, if necessary, as well known in the art. Furthermore, washers may be interposed between upper surfaces of the securing parts 312 and 322 and the nuts 62 fastened to the stud bolts 61, respectively, as well known in the art.

[0105] In addition, as described above, the first junction part 331 and the second junction part 332 are stepped to have the predetermined height difference therebetween on the top surface of the movable member 330 of the corner member. The first and sealing walls 51 and 52 are fixedly joined to the first and second junction parts 331 and 332 by welding, respectively.

[0106] Although the sealing structure is illustrated as having the double structure of the first sealing wall 51 and the second sealing wall 52 herein, the sealing structure may be embodied by a multilayer structure of three layers or more.

[0107] As such, according to this invention, the plurality of stud bolts 61 secured to the inner surface of the storage tank are inserted into the plurality of through-holes 312a and 322a formed in the securing parts 312 and 322 of the fixed member 310 and the connection member 320, and then fastened by the nuts 62, respectively, so that the fixed member 310 and the connection member 320 can be secured to the hull.

[0108] In addition, the movable member 330 joined to the sealing walls 51 and 52 is able to be minutely moved in the linear direction with respect to the fixed members by the guide recesses 313 and the guide protrusions 333, and is fixedly welded to the connection member 320 via the welding slots 335, so that the sealing walls 51 and 52 can be secured to the hull.

[0109] According to the present invention, since the fixed members 310 and the connection member 320 constituting the corner member 301 are coupled to the inner surface of the storage tank at a plurality of consecutive locations, and the movable member 330 can be linearly moved with respect to the fixed members 310, it is possible to assure absorption of stress resulting from the thermal deformation caused by the loading and unloading of LNG or from the deformation of the hull caused by the external force such as waves.

[0110] In the above embodiments of the anchor member and the corner member constituting the LNG storage tank according to this invention, the fixed member and the connection member are described as being secured to the inner surface of the hull by a mechanical coupling manner such as bolts and nuts. However, it should be noted that the present invention is not limited to this structure, and that the securing parts of the fixed member and the connection member can be directly welded to the inner surface of the hull.

[0111] Furthermore, the anchor member may have other polygonal cone shapes, such as a triangular pyramid, a quadrangular pyramid, etc., as well as the frustoconical shape.

[0112] Although the sealing walls are formed from corrugated stainless steel used for, for example, GTT Mark-III type, according to the embodiments, the sealing walls may be formed from Inva steel used for GTT NO 96.

[0113] Furthermore, it is that the present invention can be applicable to an LNG storage tank on the land as well as the LNG storage tank in the hull of the marine vessel.

[0114] As apparent from the above description, the anchor structure and the corner structure of the LNG storage tank according to the present invention can provide a simple construction of the heat insulating wall and the sealing walls, and a simple connecting structure therebetween, enabling convenient assembly thereof. In addition, the anchor structure and the corner structure of the invention increase the reliability of sealing while simplifying the assembled structure and manufacturing process of the storage tank, reducing the construction time of the storage tank. Furthermore, the anchor structure and the corner structure of the invention efficiently relieve mechanical stress exerted on the storage tank.

[0115] It should be understood that the embodiments and the accompanying drawings have been described for illustrative purposes, and the present invention is limited only by the following claims. Further, those skilled in the art will appreciate that various modifications, additions and substitutions are allowed without departing from the scope and spirit of the invention according to the accompanying claims.

Claims

1. A structure for a liquefied natural gas (LNG) storage tank (10) comprising a heat insulating wall disposed on an inner surface (12, 14) of the LNG storage tank to form a heat insulating layer, sealing walls (51, 52) disposed on the heat insulating wall to contact LNG, and the structure to support the sealing walls,
characterized in that the structure comprises an anchor structure (100) including an anchor member (110, 130) connected between the sealing walls (51, 52) and the inner surface (12, 14) of the storage tank (10) to secure the sealing walls to the inner surface of the storage tank, and a heat-insulating material (203) formed around the anchor member (110), the anchor member being coupled at a plurality of locations to the inner surface of the storage tank (10).

2. The structure according to claim 1, **characterized in that** the anchor member (110) comprises a frustoconical body (111) closed at an upper portion and opened at a lower portion, and a securing part (112) disposed at the lower portion of the frustoconical body to secure the anchor member to the inner surface (12, 14) of the storage tank (10).

3. The structure according to claim 2, **characterized in that** the securing part (112) has a ring shape formed along an overall outer circumference at a lower end of the body of the anchor member (110), and is formed with a plurality of through-holes (112a).

4. The structure according to any one of claims 1 to 3, **characterized in that** the anchor member (110) comprises a frustoconical body (111) having a junction part formed at an upper portion of the body, the junction part being joined to the sealing walls and including a first junction part (113) and a second junction part (114) stepped to have a predetermined height difference.

5. The structure according to claim 1, **characterized in that** the anchor member (130) comprises a securing part (132) formed at a lower portion of the anchor member to secure the anchor member to the inner surface (12, 14) of the storage tank, and a junction part formed at an upper portion of the anchor member and joined to the sealing walls (51, 52), the securing part and the junction part being integrally formed with lower and upper ends of a body (131) of the anchor member (130), respectively.

6. The structure according to claim 5, **characterized in that** the junction part comprises a first junction part (133) and a second junction part (134) stepped to have a predetermined height difference, and the anchor member (130) further comprises a reinforcing plate (135) mounted inside the upper end of the anchor member to provide a double structure to the upper portion of the anchor member where the first and second junction parts are formed.

7. The structure according to any one of claims 1 to 6, **characterized in that** the anchor member (130) comprises a body (131) having a plurality of holes (131a) arranged in a zigzag pattern.

8. The structure according to any one of claims 1 to 7,

characterized in that the heat-insulating material (103) of the anchor structure (110) has a lower density than that of a planar heat-insulating material (203) for a planar structure (200) formed around the anchor structure (110).

9. The structure according to any one of claims 1 to 8, **characterized in that** the structure constituting the LNG storage tank (10) further comprises a corner structure disposed at a corner of the storage tank to support the sealing walls (51, 52), and
wherein the corner structure comprises a corner member (301) connected between the sealing walls (51, 52) and the inner surface of the storage tank (10) to secure the sealing wall to the inner surface thereof, and a heat-insulating material (303) formed around the corner member, the corner member (301) comprising a fixed member (310) secured to the inner surface of the corner of the storage tank, and a movable member (330) supported on the fixed member to move linearly on the fixed member (310).

10. The structure according to claim 9, **characterized in that** the corner member (301) further comprises a connection member (320) to connect and secure the movable member (330) to the inner surface of the corner of the storage tank (10).

11. The structure according to claim 10 **characterized in that** the fixed member (310) and the connection member (320) of the corner member (301) are coupled at a plurality of locations to the inner surface of the corner of the storage tank (10).

12. The structure according to claim 11, **characterized in that** each of the fixed member (310) and the connection member (320) comprises a securing part (312) having a plurality of through-holes (312a) formed therein.

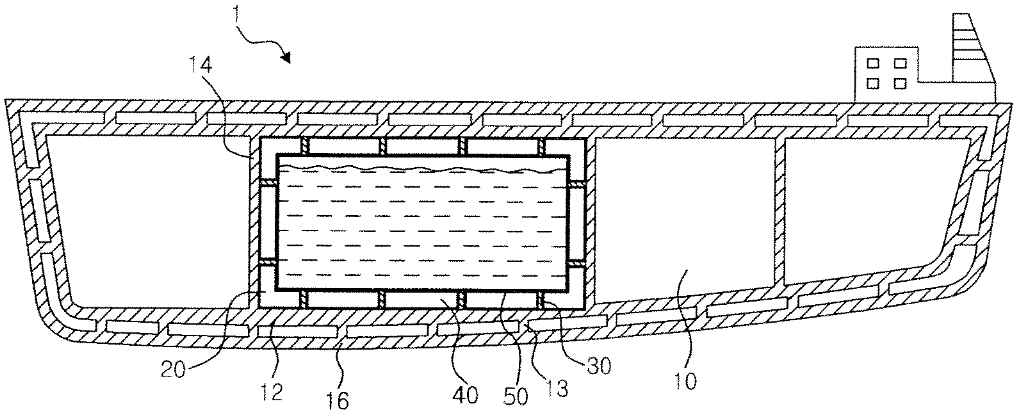
13. The structure according to any one of claims 9 to 12, **characterized in that** the movable member (330) of the corner member comprises a junction part to which the sealing walls (51, 52) are joined, the junction part comprising a first junction part (331) and a second junction part (332) stepped to have a predetermined height difference.

14. The structure according to any one of claims 9 to 13, **characterized in that** the fixed member (310) comprises a guide recess (313) and the movable member (330) comprises a guide protrusion (333), the movable member (330) being linearly moved on the fixed member (310) by the guide recess (313) and the guide protrusion (333).

15. The structure according to claim 14, **characterized in that** the guide protrusion (333) is produced independent of the movable member (330), and integrally welded to the movable member (330) to match a location of the guide recess (313) of the fixed member (310) after positioning the movable member on the fixed member.

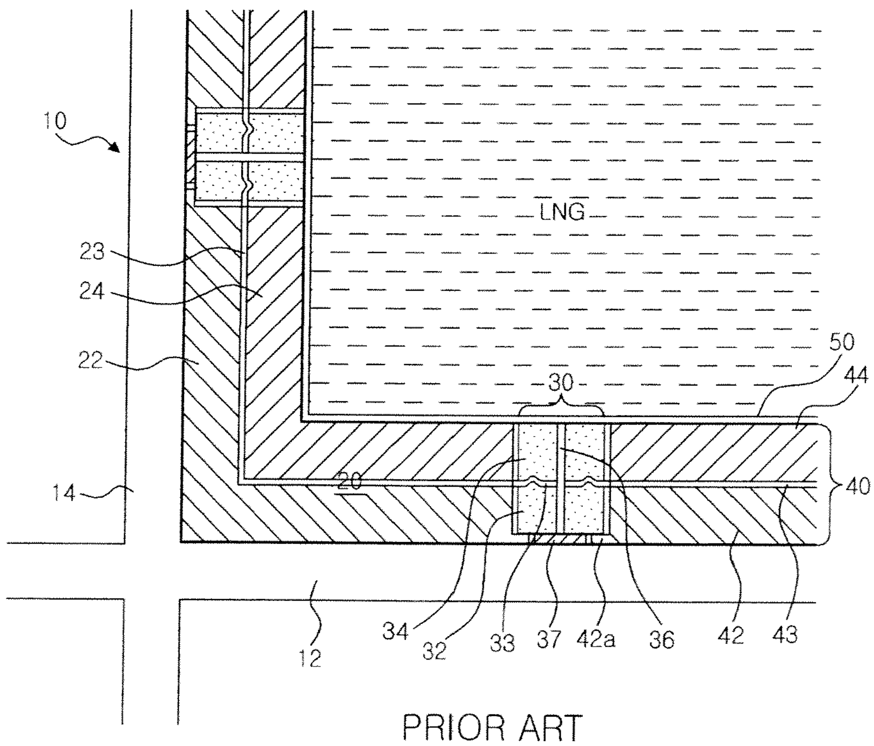
16. The structure according to claim 10 and any one of claims 11 to 15, **characterized in that** the connection member (320) comprises securing parts (322) formed at one end of the connection member and is joined at the other end to the movable member (330) by welding, and the movable member comprises welding slots (336) formed at portions of the movable member (330) joined to the connection member (320).

Fig. 1



PRIOR ART

Fig. 2



PRIOR ART

Fig. 3

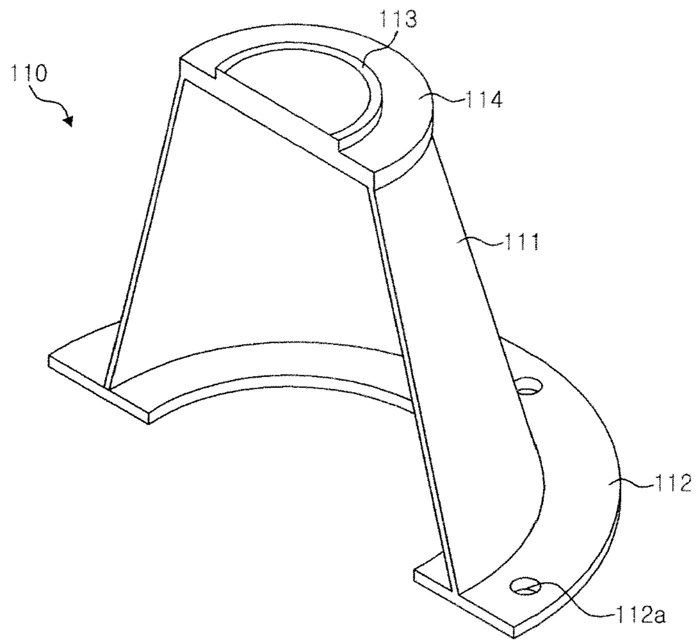


Fig. 4

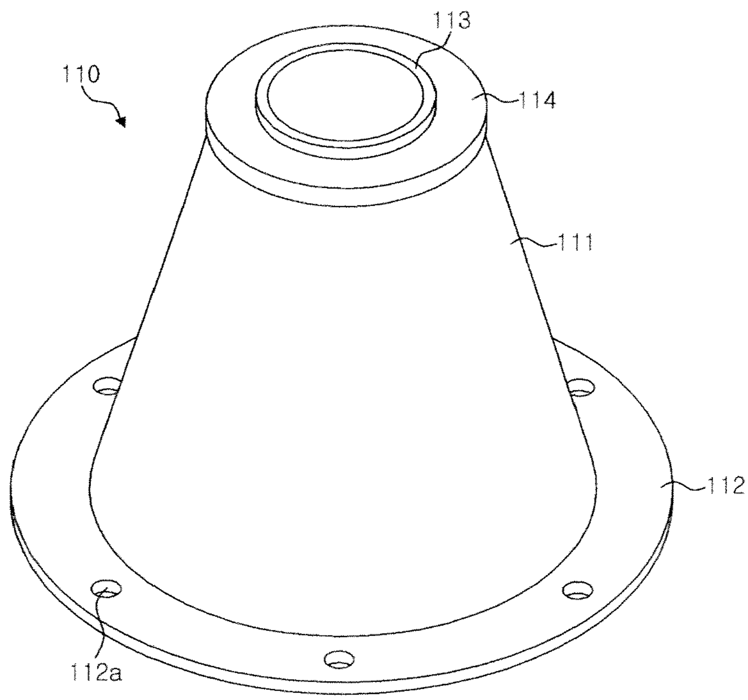


Fig. 5

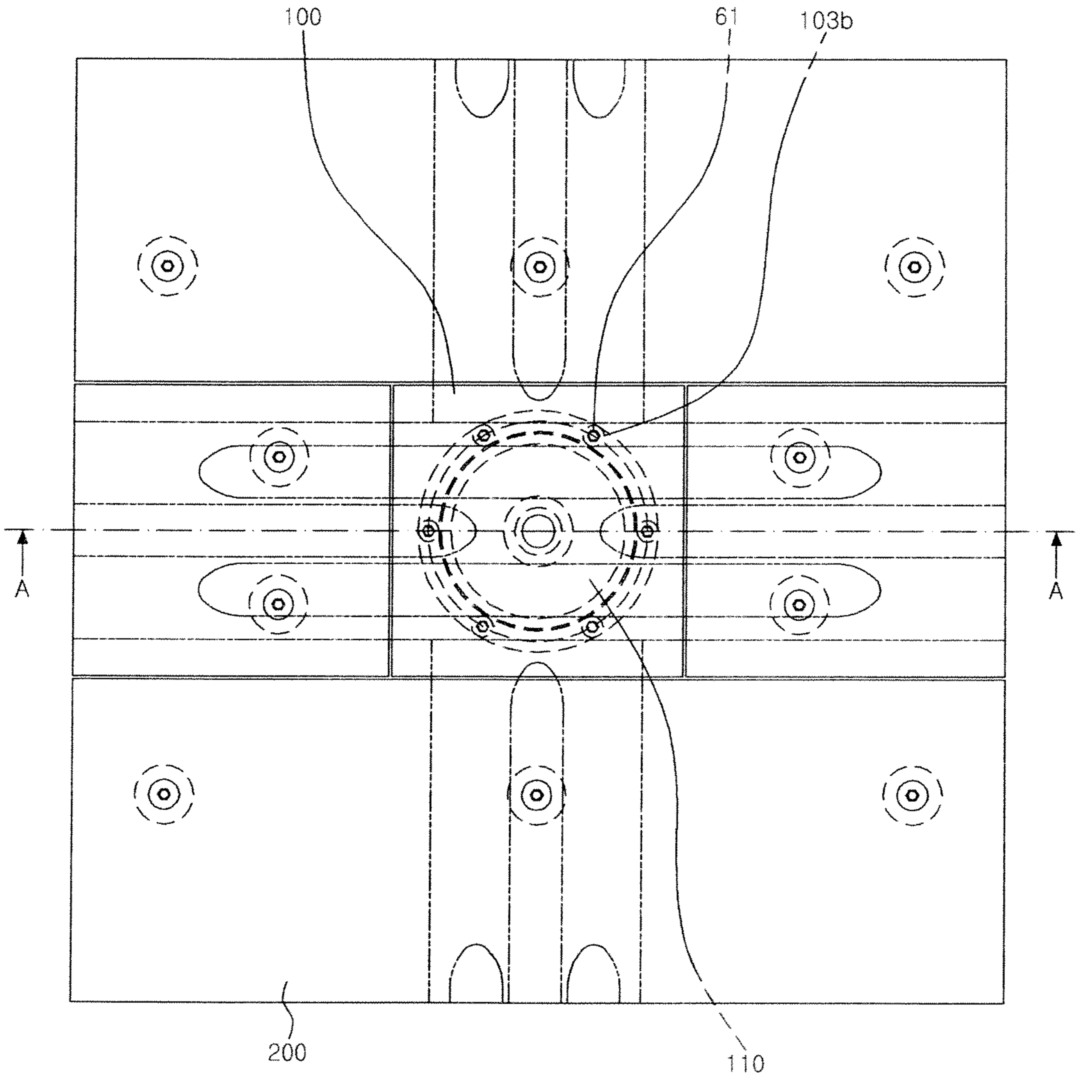


Fig. 6

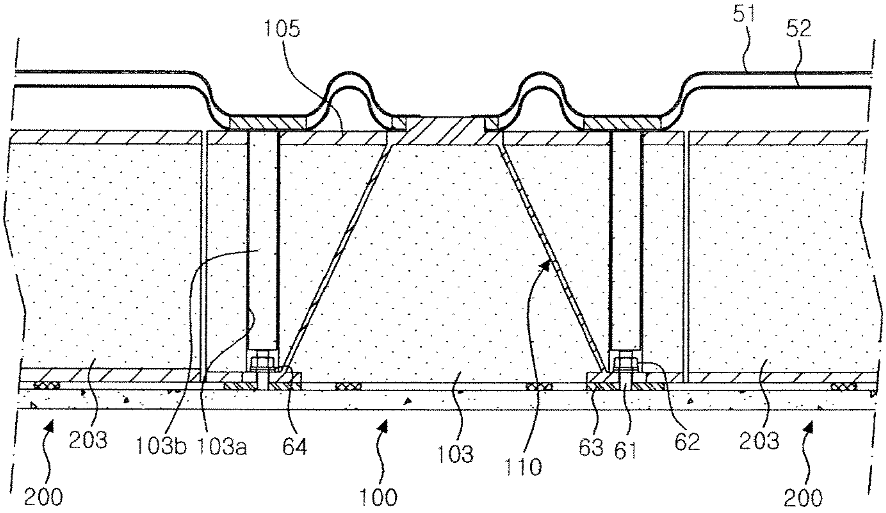

105
51
52
203
103b
103a
64
103
110
63
61
62
203
200
100
200

Fig. 7

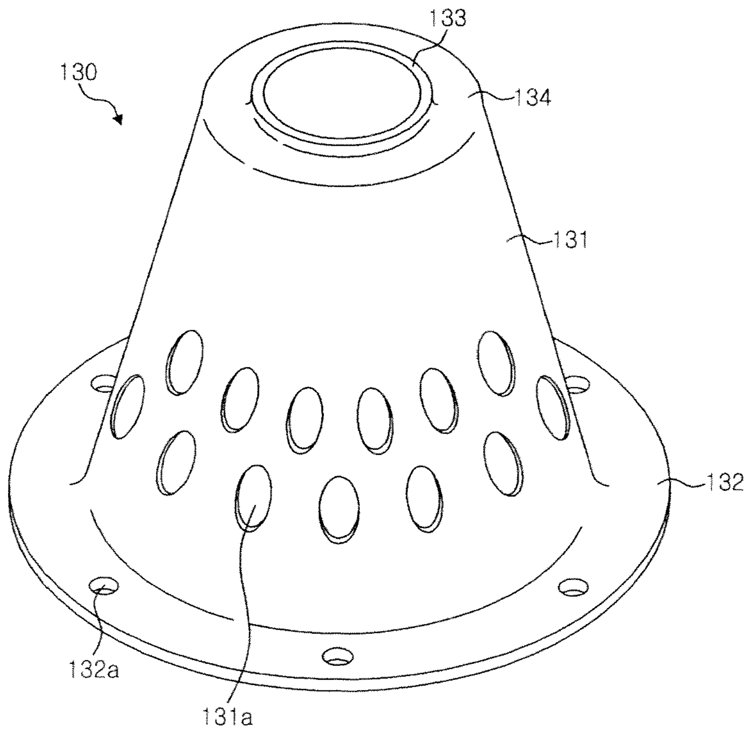

133
130
134
131
132
132a
131a

Fig. 8

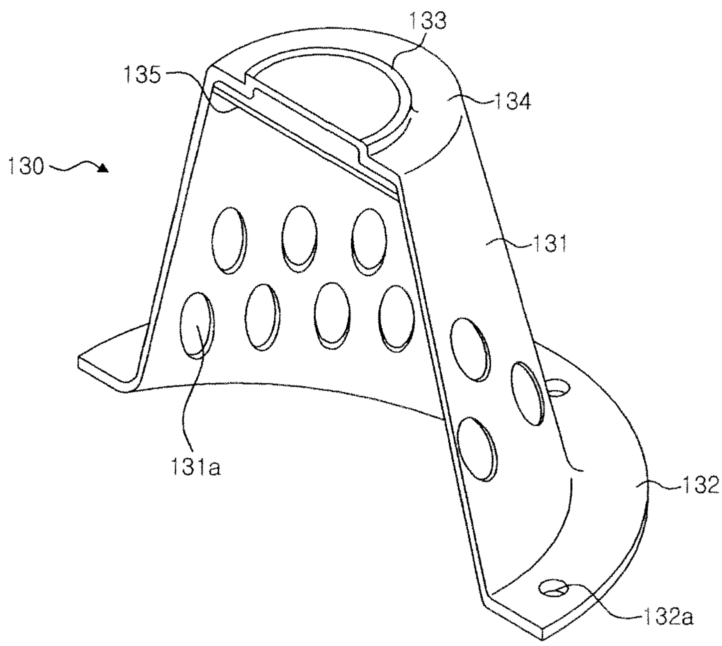


Fig. 9

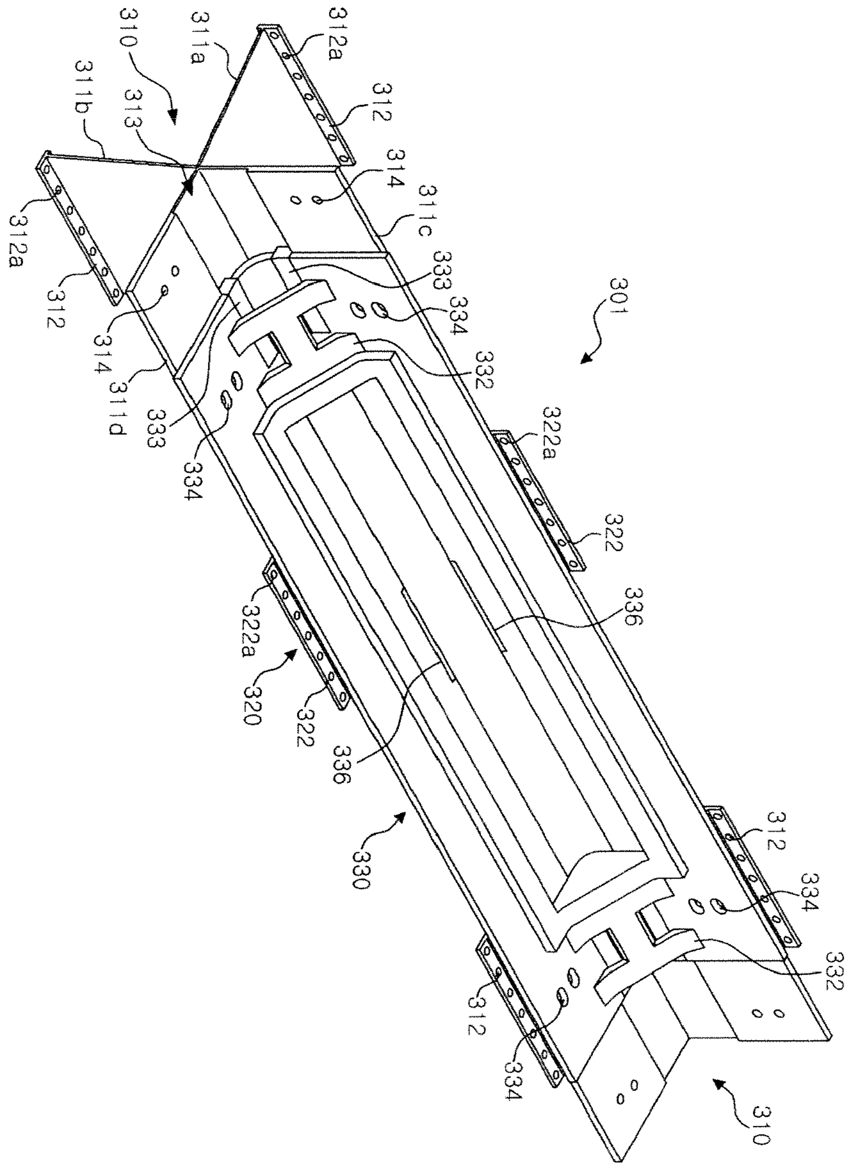
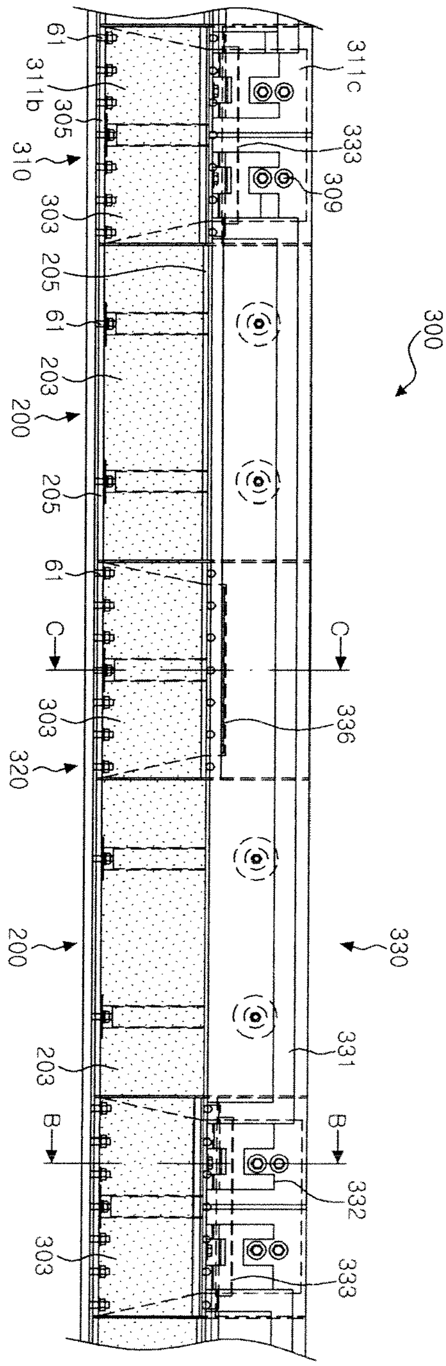

301
310
311a
311b
311c
311d
312
312a
313
314
320
322
322a
330
332
333
334
336

Fig. 10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311b
305
310
303
205
61
203
200
205
61
C
303
320
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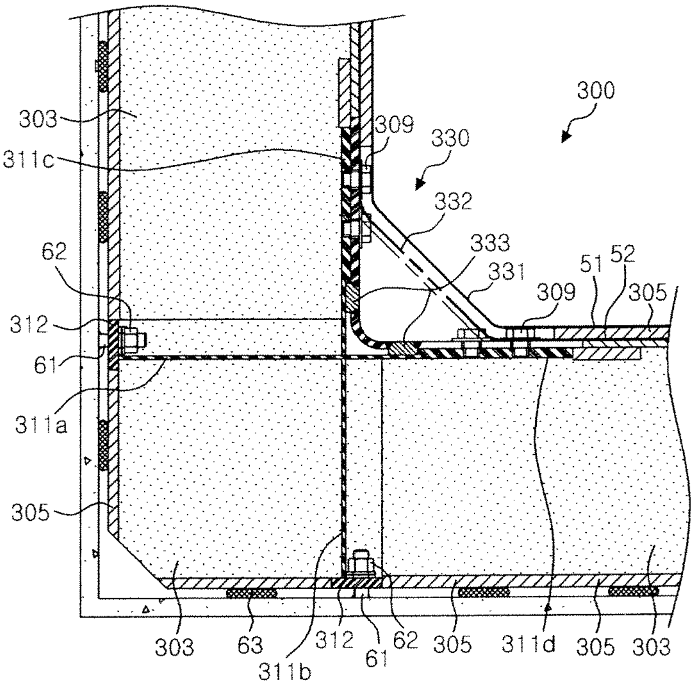
203
B
303
311c
333
309
300
C
336
330
331
B
332
333

Fig. 11


300
303
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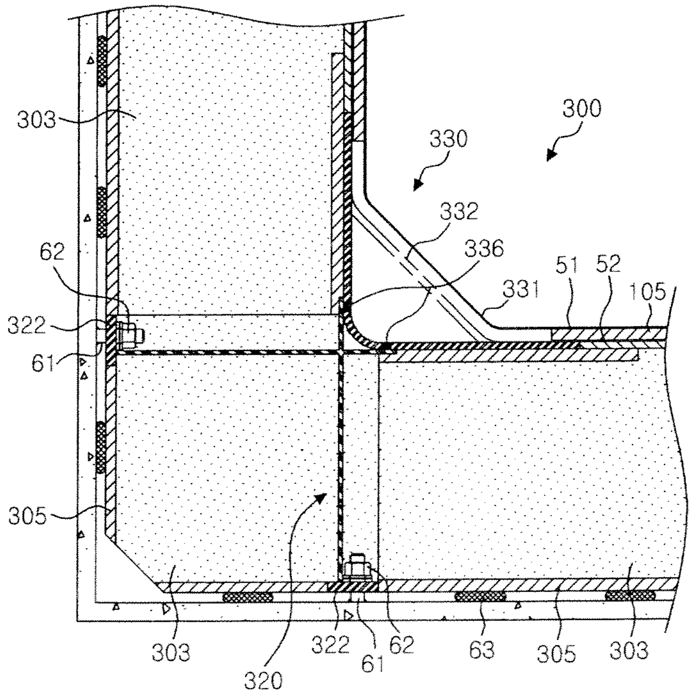
330
311c
332
62
333
331
51
52
309
305
312
61
311a
305
303
63
312
61
62
305
311d
305
303
311b

Fig. 12


300
303
330
332
62
336
51
52
331
105
322
61
305
303
320
322
61
62
63
305
303

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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